General

Guideline Title

Critical care management of patients following aneurysmal subarachnoid hemorrhage: recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference.

Bibliographic Source(s)

Diringer MN, Bleck TP, Claude Hemphill J 3rd, Menon D, Shutter L, Vespa P, Bruder N, Connolly ES Jr, Citerio G, Gress D, Hanggi D, Hoh BL, Lanzino G, Le Roux P, Rabinstein A, Schmutzhard E, Stocchetti N, Suarez JI, Treggiari M, Tseng MY, Vergouwen MD, Wolf S, Zipfel G, Neurocritical Care Society. Critical care management of patients following aneurysmal subarachnoid hemorrhage: recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference. Neurocrit Care. 2011 Sep;15(2):211-40. [199 references] PubMed

Guideline Status

This is the current release of the guideline.

Recommendations

Major Recommendations

Definitions of the strength of recommendations (*strong, weak)* and quality of the evidence (*high, moderate, low, very low*) are provided at the end of the "Major Recommendations" field.

Measures to Prevent Rebleeding

- Early aneurysm repair should be undertaken, when possible and reasonable, to prevent rebleeding (*high quality evidence; strong recommendation*).
- An early, short course of antifibrinolytic therapy prior to early aneurysm repair (begun at diagnosis; continued up to the point at which the aneurysm is secured or at 72 h post-ictus, whichever is shorter) should be considered (*low quality evidence; weak recommendation*).
- Delayed (>48 h after the ictus) or prolonged (>3 days) antifibrinolytic therapy exposes patients to side effects of therapy when the risk of rebleeding is sharply reduced and should be avoided (*high quality evidence; strong recommendation*).
- Antifibrinolytic therapy is relatively contraindicated in patients with risk factors for thromboembolic complications (*moderate quality evidence; strong recommendation*).
- Patients treated with antifibrinolytic therapy should have close screening for deep venous thrombosis (*moderate quality evidence; strong recommendation*).
- Antifibrinolytic therapy should be discontinued 2 h before planned endovascular ablation of an aneurysm (*very low quality evidence; weak recommendation*).

- When computed tomographic angiography (CTA) and digital subtraction angiography (DSA) are both available and CTA is of high technical quality, CTA should be performed preferentially if endovascular intervention is not planned at the time of angiography (*very low quality evidence; weak recommendation*).
- Treat extreme hypertension in patients with an unsecured, recently ruptured aneurysm. Modest elevations in blood pressure (mean blood pressure <110 mmHg) do not require therapy. Pre-morbid baseline blood pressures should be used to refine targets; hypotension should be avoided (*low quality evidence; strong recommendation*).

Seizures and Prophylactic Anticonvulsant Use

- Routine use of anticonvulsant prophylaxis with phenytoin is not recommended after subarachnoid hemorrhage (SAH) (*low quality evidence; strong recommendation*).
- Routine use of other anticonvulsants for prophylaxis may be considered (*very low quality evidence; weak recommendation*).
- If anticonvulsant prophylaxis is used, a short course (3–7 days) is recommended (*low quality evidence; weak recommendation*).
- In patients who suffer a seizure after presentation, anticonvulsants should be continued for a duration defined by local practice (*low quality evidence; weak recommendation*).
- Continuous electroencephalographic (EEG) monitoring should be considered in patients with poor-grade SAH who fail to improve or who have neurological deterioration of undetermined etiology (*low quality evidence; strong recommendation*).

Cardiopulmonary Complications

Monitoring

- Baseline cardiac assessment with serial enzymes, electrocardiography, and echocardiography is recommended, especially in patients with evidence of myocardial dysfunction (*low quality evidence; strong recommendation*).
- Monitoring of cardiac output may be useful in patients with evidence of hemodynamic instability or myocardial dysfunction (*low quality evidence; strong recommendation*).

Treatment

- In case of pulmonary edema or evidence of lung injury, the goal of therapy should include avoiding excessive fluid intake and judicious use of diuretics targeting euvolemia (*moderate quality evidence; strong recommendation*).
- Standard management of heart failure is indicated with the exception that cerebral perfusion pressure/mean arterial pressure (CPP/MAP) should be maintained as appropriate for the neurological condition (*moderate quality evidence; strong recommendation*).

Monitoring Intravascular Volume Status

- Monitoring of volume status may be beneficial (*moderate quality evidence; weak recommendation*).
- Vigilant fluid balance management should be the foundation for monitoring intravascular volume status. While both non-invasive and invasive monitoring technologies are available, no specific modality can be recommended over clinical assessment (*moderate quality evidence; weak recommendation*).
- Central venous lines should not be placed solely to obtain central venous pressure (CVP) measures, and fluid management based solely on CVP measurements is not recommended (*moderate quality evidence; strong recommendation*).
- Use of pulmonary artery catheters (PACs) incurs risk and lacks evidence of benefit. Routine use of PACs is not recommended (*moderate quality evidence; strong recommendation*).

Managing Intravascular Volume Status

- Intravascular volume management should target euvolemia and avoid prophylactic hypervolemic therapy. In contrast, there is evidence for harm from aggressive administration of fluid aimed at achieving hypervolemia (*high quality evidence; strong recommendation*).
- Isotonic crystalloid is the preferred agent for volume replacement (*moderate quality evidence; weak recommendation*).
- In patients with a persistent negative fluid balance, use of fludrocortisone or hydrocortisone may be considered (*moderate quality evidence; weak recommendation*).

Glucose Management

- Hypoglycemia (serum glucose <80 mg/dl) should be avoided (*high quality evidence; strong recommendation*).
- Serum glucose should be maintained below 200 mg/dl (*moderate quality evidence; strong recommendation*).
- If microdialysis is being used, serum glucose may be adjusted to avoid low cerebral glucose (*very low quality evidence; weak recommendation*).

Management of Pyrexia

- Temperature should be monitored frequently; infectious causes of fever should always be sought and treated (*high quality evidence; strong recommendation*).
- During the period of risk for delayed cerebral ischemia (DCI) control of fever is desirable; intensity should reflect the individual patient's relative risk of ischemia (*low quality evidence; strong recommendation*).
- While the efficacy of most antipyretic agents (acetaminophen, ibuprofen) is low, they should be used as the first line of therapy (*moderate quality evidence; strong recommendation*).
- Surface cooling or intravascular devices are more effective and should be employed when antipyretics fail in cases where fever control is highly desirable (*high quality evidence; strong recommendation*).
- Use of these devices should be accompanied by monitoring for skin injury and venous thrombosis (*weak quality evidence; strong recommendation*).
- Patients should be monitored and treated for shivering (*high quality evidence; strong recommendation*).

Deep Venous Thrombosis Prophylaxis

- Measures to prevent deep venous thrombosis should be employed in all SAH patients (*high quality evidence; strong recommendation*).
- Sequential compression devices, should be routinely used in all patients (*high quality evidence; strong recommendation*).
- The use of low molecular weight heparin or unfractionated heparin for prophylaxis should be withheld in patients with unprotected aneurysms and expected to undergo surgery (*low quality evidence; strong recommendation*).
- The use of unfractionated heparin for prophylaxis could be started 24 h after undergoing surgery (*moderate quality evidence; strong recommendation*).
- Unfractionated heparin and low molecular weighted heparin should be withheld 24 h before and after intracranial procedures (*moderate quality evidence; strong recommendation*).
- The duration of deep vein thrombosis (DVT) prophylaxis is presently uncertain but may be based on patient mobility (*low quality evidence; weak recommendation*).

Statins

- Patients on statins prior to presentation with aneurysmal SAH should have their medication continued in the acute phase (*low quality evidence; strong recommendation*).
- Acute statin therapy in statin-naive patients may be considered for reducing DCI following aneurysmal SAH, pending the outcome of ongoing trials (*moderate quality evidence; weak recommendation*).

Magnesium

- Inducing hypermagnesemia is not recommended pending the conclusion of current randomized trials (*moderate quality evidence; strong recommendation*).
- Hypomagnesemia should be avoided (*moderate quality evidence; strong recommendation*).

Definitions: Delayed Neurological Deterioration, Delayed Cerebral Ischemia and Vasospasm

- SAH clinical trials should use only radiographic evidence of cerebral infarction and functional outcome as the primary outcome measures (*moderate quality evidence; strong recommendation*).

Monitoring for DCI and Triggers for Intervention

- Monitoring for neurological deterioration, and specifically DCI, should take place in an environment with substantial multidisciplinary expertise in the management of SAH (*moderate quality evidence; strong recommendation*).
- Patients at high risk for DCI should be closely monitored throughout the at risk period. This is best accomplished in an intensive care unit (ICU) setting where additional monitoring and treatment can be rapidly implemented (*very low quality evidence; strong recommendation*).
- Oral nimodipine (60 mg every 4 h) should be administered after SAH for a period of 21 days (*high quality evidence; strong recommendation*).
- Imaging of vascular anatomy and/or perfusion can be used to confirm a diagnosis of DCI in monitored good-grade patients who show a change in neurologic exam or transcranial Doppler (TCD) variables (*high quality evidence; strong recommendation*).
- A strategy for detection and confirmation of DCI should be employed. This should first and foremost involve frequent repeat neurological

assessment by qualified providers. Intermittent screening or more continuous monitoring methods may additionally be used.

- TCD may be used for monitoring and detection of large artery vasospasm with variable sensitivity. Thresholds of mean blood flow velocities <120 cm/s for absence and >200 cm/s and/or middle cerebral artery/internal carotid artery (MCA/ICA) ratio >6 for presence are reasonable (*moderate quality evidence; strong recommendation*).
- DSA is the gold standard for detection of large artery vasospasm (*high quality evidence; strong recommendation*).
- High quality CTA can be used for screening for vasospasm, and due to its high specificity may reduce the need for DSA studies (*low quality evidence; weak recommendation*).
- Computed tomographic perfusion (CTP) findings of elevated mean transit time (MTT) >6.4 s may be additive to CTA findings in predicting DCI (*low quality evidence; weak recommendation*).
- EEG, brain tissue oxygen ($PbtO_2$) monitoring, and cerebral microdialysis (CMD) may all be useful physiological monitors for DCI detection. Data from probes should be interpreted in light of its limited field of view and location in relation to pathology. The relative value of these monitors individually versus as part of a multi-modality monitoring strategy is not known (*low quality evidence; weak recommendation*).

- In high risk patients who have a clinical picture strongly suggestive of DCI, and in whom elective screening CTA/CTP or DSA has already demonstrated vasospasm/DCI, it is reasonable to initiate medical therapy without further investigations (*moderate quality evidence; strong recommendation*).
- In patients where there is clinical uncertainty regarding the cause of neurological deterioration, DSA is indicated if an endovascular intervention is planned (*moderate quality evidence; strong recommendation*).
- In sedated or poor-grade SAH patients, clinical deterioration may be difficult to assess, and TCD, continuous EEG, $PbtO_2$ monitoring, and/or CMD are options for monitoring for vasospasm and DCI (*low quality evidence; weak recommendation*).
- Elective screening with CTP/CTA or DSA on may provide additional information (*low quality evidence; weak recommendation*).

Hemodynamic Management of DCI

Intravascular Volume

- The goal should be maintaining euvolemia, rather than attempting to induce hypervolemia (*moderate quality evidence; strong recommendation*).
- Consider a saline bolus to increase cerebral blood flow (CBF) in areas of ischemia as a prelude to other interventions (*moderate quality evidence; weak recommendation*).

Blood Pressure

- Patients clinically suspected of DCI should undergo a trial of induced hypertension (*moderate quality evidence; strong recommendation*).
- The choice of vasopressor should be based on the other pharmacologic properties of the agents (e.g., inotropy, tachycardia) (*moderate quality evidence; strong recommendation*).
- Blood pressure augmentation should progress in a stepwise fashion with assessment of neurologic function at each MAP level to determine if a higher blood pressure target is appropriate (*low quality evidence; strong recommendation*).
- If nimodipine administration results in hypotension, then dosing intervals should be changed to more frequent lower doses. If hypotension continues to occur, then nimodipine may be discontinued (*low quality; strong recommendation*).

Inotropy

- If patients with DCI do not improve with blood pressure augmentation, a trial of inotropic therapy may be considered (*low quality evidence; strong recommendation*).
- Inotropes with prominent β-2 agonist properties (e.g., dobutamine) may lower MAP and require increases in vasopressor dosage (*high quality evidence; strong recommendation*).
- Mechanical augmentation of cardiac output and arterial blood flow (e.g., intra-aortic balloon counter-pulsation) may be useful (*low quality evidence; weak recommendation*).

Hemodilution

- Hemodilution in an attempt to improve rheology should not be undertaken except in cases of erythrocythemia (*moderate quality evidence; strong recommendation*).

Patients with DCI Who Have Unsecured Aneurysms

- If the aneurysm thought to have ruptured is unsecured when a patient develops DCI, cautious blood pressure elevation to improve perfusion might be attempted, weighing potential risks and benefits (*Weak quality evidence; strong recommendation*).
- Unsecured aneurysms which are not thought to be responsible for the acute SAH should not influence hemodynamic management (*Moderate quality evidence; strong recommendation*).

Endovascular Management of DCI

- Endovascular treatment using intra-arterial vasodilators and/or angioplasty may be considered for vasospasm related DCI (*moderate quality evidence; strong recommendation*).
- The timing and triggers of endovascular treatment of vasospasm remains unclear, but generally rescue therapy for ischemic symptoms that remain refractory to medical treatment should be considered. The exact timing is a complex decision which should consider the aggressiveness of the hemodynamic intervention, the patients' ability to tolerate it, prior evidence of large artery narrowing, and the availability of and the willingness to perform angioplasty or infusion of intra-arterial agents (*moderate quality evidence; strong recommendation*).
- The use of routine prophylactic cerebral angioplasty is not recommended (*high quality evidence; strong recommendation*).

Anemia and Transfusion

- Measures should be taken to minimize blood loss from blood drawing (*low quality evidence; strong recommendation*).
- Transfusion criteria for general medical patients should not be applied to decisions in SAH patients.
- Patients should receive packed red blood cell (RBC) transfusions to maintain hemoglobin concentration above 8–10 g/dl (*Moderate quality evidence; strong recommendation*).
- Higher hemoglobin concentrations may be appropriate for patients at risk for DCI, but whether transfusion is useful cannot be determined from the available data (*No evidence; strong recommendation*).

Management of Hyponatremia

- Fluid restriction should not be used to treat hyponatremia (*low quality evidence; strong recommendation*).
- Early treatment with hydrocortisone or fludrocortisone may be used to limit natriuresis and hyponatremia (*moderate quality evidence; weak recommendation*).
- Mild hypertonic saline solutions can be used to correct hyponatremia (*very low quality evidence; strong recommendation*).
- Extreme caution to avoid hypovolemia is needed if vasopressin-receptor antagonists are used for treatment of hyponatremia (*low quality evidence; strong recommendation*).
- Free water intake via intravenous and enteral routes should be limited (*very low quality evidence; strong recommendation*).

Endocrine Function

- Hypothalamic dysfunction should be considered in patients who are unresponsive to vasopressors. The optimal method of diagnosis remains unclear (*moderate quality evidence; weak recommendation*).
- Routine administration of high dose corticosteroids is not recommended in acute SAH (*high quality evidence; weak recommendation*).
- Hormonal replacement with mineralocorticoids should be considered in acute SAH to prevent hypovolemia and hyponatremia (*moderate quality evidence; weak recommendation*).
- Hormonal replacement with stress-dose corticosteroids for patients with vasospasm and unresponsiveness to induced hypertension may be considered (*low quality evidence; weak recommendation*).

High Volume Centers

- Patients with SAH should be treated at high volume centers (*moderate quality evidence; strong recommendation*).
- High volume centers should have appropriate specialty neurointensive care units, neurointensivists, vascular neurosurgeons and interventional neuroradiologists to provide the essential elements of care (*moderate quality evidence; strong recommendation*).

Definitions:

Quality of the Evidence

High = Further research is very unlikely to change confidence in the estimate of effect.

Moderate = Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.

Low = Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.

Very low = Any estimate of effect is very uncertain.

Strength of Recommendations

The Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system classifies recommendations as strong or weak, according to the balance among benefits, risks, burden, and cost, and according to the quality of evidence. Keeping those components explicitly separate constitutes a crucial and defining feature of this grading system. An advantage of the GRADE system is that it allows for strong recommendations in the setting of lower quality evidence and thus it is well suited to this situation. Recommendations were either strong or weak and based on the following:

- The trade-offs, taking into account the estimated size of the effect for the main outcomes, the confidence limits around those estimates, and the relative value placed on each outcome
- The quality of the evidence
- Translation of the evidence into practice in a specific setting, taking into consideration important factors that could be expected to modify the size of the expected effects

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Aneurysmal subarachnoid hemorrhage

Guideline Category

Evaluation

Management

Treatment

Clinical Specialty

Anesthesiology

Critical Care

Internal Medicine

Neurological Surgery

Neurology

Radiology

Intended Users

Advanced Practice Nurses

Nurses

Pharmacists

Physician Assistants

Physicians

Guideline Objective(s)

To develop recommendations for the critical care management of patients following acute aneurysmal subarachnoid hemorrhage (SAH)

Target Population

Patients with acute aneurysmal subarachnoid hemorrhage

Interventions and Practices Considered

1. Measures to prevent rebleeding
    - Early aneurysm repair
    - Antifibrinolytic therapy
    - Computed tomographic angiography (CTA) and digital subtraction angiography (DSA)
    - Treating hypertension
2. Prophylactic anticonvulsant use
3. Continuous electroencephalographic (EEG) monitoring
4. Monitoring and treatment of cardiopulmonary complications
5. Monitoring and managing intravascular volume status targeting euvolemia
    - Use of isotonic crystalloid for volume replacement
    - Fludrocortisone or hydrocortisone
6. Glucose management (avoiding hypoglycemia)
7. Management of pyrexia
    - Monitoring temperature
    - Treating infectious causes of fever
    - Use of antipyretic agents (acetaminophen, ibuprofen)
    - Surface cooling or intravascular devices
    - Monitoring for skin injuries and shivering
8. Deep vein thrombosis prophylaxis
    - Sequential compression devices
    - Use of low-molecular-weight or unfractionated heparins
9. Use of statins
10. Inducing hypermagnesemia (not recommended; hypomagnesemia should be avoided)
11. Monitoring for neurological deterioration, specifically delayed cerebral ischemia (DCI)
    - Imaging of vascular anatomy and perfusion
12. Hemodynamic management of DCI
    - Maintaining euvolemia
    - Saline bolus to increase cerebral blood flow
    - Trial of induced hypertension
    - Inotropic therapy (e.g., dobutamine)
    - Mechanical augmentation of cardiac output and arterial blood flow
    - Hemodilution (not recommended routinely)
    - Managing patients with DCI who have unsecured aneurysms
13. Endovascular management of DCI using intra-arterial vasodilators and/or angioplasty
14. Management of anemia with packed red blood cells
15. Management of hyponatremia

    - Hydrocortisone or fludrocortisone
    - Mild hypertonic saline solutions
    - Limiting water intake
16. Monitoring and managing endocrine function
    - Use of high-dose corticosteroids (specifically not recommended)
    - Hormonal replacement with stress-dose corticosteroids
17. Treatment of patients at high-volume centers

Major Outcomes Considered

- Cardiopulmonary complications
- Rebleeding episodes
- Seizures
- Pyrexia
- Hypoglycemia
- Deep venous thrombosis
- Delayed neurological deterioration
- Vasospasm
- Delayed cerebral ischemia
- Hyponatremia
- Anemia
- Endocrine dysfunction
- Functional outcome

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Topics were identified based on clinical decision points in the critical care management of subarachnoid hemorrhage (SAH) patients. Experts drawn from Europe and North America from the fields of neurosurgery, neurocritical care, neurology, interventional neuroradiology, and neuroanesthesiology were recruited based on their expertise related to each topic. A jury of four experienced neurointensivists was selected for their expertise in clinical investigation and development of practice guidelines. Each participant performed a critical literature review.

Pubmed, Medline, Embase (Ovid), Index Medicus, the Cochrane Library and the Cochrane Controlled Trials Registry, and National Institutes of Health/National Library of Medicine Clinical Trials Registry were searched from 1980 through March 2011 (databases and time frames of the search varied by topic). For the information on anemia and transfusion, the bibliographies of retrieved articles were also reviewed, the "Related Articles" feature of PubMed was used, and expert consultation was also sought. In general, only English language articles were included, although French, Spanish, and Italian were included for the topic on aggression interventions for SAH. Most searches focused on original research in human subjects, but a few topics were broader in scope. The specific search terms used varied by topic.

Number of Source Documents

Not stated

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

The quality of the data was assessed and recommendations developed using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system. The quality of the evidence was graded as:

High = Further research is very unlikely to change confidence in the estimate of effect.

Moderate = Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.

Low = Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.

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Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The findings were summarized in tables and a summary was prepared which reviewed the data and provided specific management recommendations. These were submitted in draft form before the conference and distributed to all participants.

Methods Used to Formulate the Recommendations

Expert Consensus (Consensus Development Conference)

Description of Methods Used to Formulate the Recommendations

The Neurocritical Care Society organized an international, multidisciplinary consensus conference on the critical care management of subarachnoid hemorrhage (SAH). Recommendations were developed based on literature review using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system, discussion integrating the literature with the collective experience of the participants and critical review by an impartial jury. Emphasis was placed on the principle that recommendations should be based not only on the quality of the data but also tradeoffs and translation into practice. Strong consideration was given to providing guidance and recommendations for all issues faced in the daily management of SAH patients, even in the absence of high quality data.

The conference took place on October 22–23, 2010. Each participant presented a summary of the data and recommendations to the jury and other participants. Presentations were followed by discussion focused on refining the proposed management recommendations. Approximately 1/3 of the conference time was utilized for discussion.

The jury met for 2 days after the conference and again at a subsequent 2-day meeting and held several conference calls. They reviewed selected key studies, the recommendations made by the primary reviewers and the discussion that took place at the conference.

Rating Scheme for the Strength of the Recommendations

The Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system classifies recommendations as strong or weak, according to the balance among benefits, risks, burden, and cost, and according to the quality of evidence. Keeping those components explicitly separate constitutes a crucial and defining feature of this grading system. An advantage of the GRADE system is that it allows for strong recommendations in the setting of lower quality evidence and thus it is well suited to this situation. Recommendations were either strong or weak and based on the following:

- The trade-offs, taking into account the estimated size of the effect for the main outcomes, the confidence limits around those estimates, and

the relative value placed on each outcome
- The quality of the evidence
- Translation of the evidence into practice in a specific setting, taking into consideration important factors that could be expected to modify the size of the expected effects

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Not stated

Description of Method of Guideline Validation

Not applicable

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Appropriate management of patients following aneurysmal subarachnoid hemorrhage

Potential Harms

- Aneurysm repair procedures have significant risks and require experienced teams to minimize the serious procedural side effects of repair. This fact can lead to further delay in repair, and increase the risk of rebleeding.
- Red cell transfusion has been associated with medical complications and infection. Thus, while higher hemoglobin targets may be desirable in subarachnoid hemorrhage (SAH) patients, the increased risk of transfusion must be considered.
- In controlled studies, use of corticosteroids was associated with increased incidence of hyperglycemia and hypokalemia, both of which were treatable. The incidence of congestive heart failure or pulmonary edema did not appear to be significantly increased.
- Vasopressin-receptor antagonists, such as conivaptan, are effective for the treatment of hyponatremia associated with euvolemic or hypervolemic conditions and in hyponatremic SAH patients. They can, however, produce a significant rise in urine output raising concern about intravascular volume contraction, especially in the setting of delayed cerebral ischemia (DCI).
- Suppression of infectious fever has risk. Fever is an adaptive host response to infection. In a number of different clinical settings treatment of fever results in a prolonged course of illness. No study has prospectively addressed the impact of fever control on neurologic injury, infection or outcome in SAH patients.
- Aggressive means to control fever can cause shivering. The metabolic consequences include a marked increase in resting energy expenditure, carbon dioxide production, systemic oxygen consumption and a decrease in brain tissue oxygen tension.
- There was concern that aggressive control of serum glucose using insulin infusions could result in inappropriately low cerebral glucose levels, and that in most situations, this would go undetected because microdialysis is not widely available as a clinical management tool. There was also concern that low cerebral glucose levels may occur even in the setting of low-normal serum glucose levels. There was also recognition

that systemic hypoglycemic events are more common with insulin infusions, especially with a tight target glucose range.
- There is a risk of brain hemorrhage when unfractionated or low-molecular-weight heparins are used for deep vein thrombosis prophylaxis.

Contraindications

Contraindications

Antifibrinolytic therapy is relatively contraindicated in patients with risk factors for thromboembolic complications.

Qualifying Statements

Qualifying Statements

This statement is provided as an educational service of the Neurocritical Care Society. It is based on an assessment of current literature and the consensus of the opinions of the attendees and jury of the conference. It is not intended to include all possible proper methods of care for subarachnoid hemorrhage (SAH) patients. Neither is it intended to exclude any reasonable alternative methodologies. The Neurocritical Care Society recognizes that specific patient care decisions are the prerogative of the patient and the physician caring for the patient, based on all of the circumstances involved. No formal practice recommendations should be inferred.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Slide Presentation

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Diringer MN, Bleck TP, Claude Hemphill J 3rd, Menon D, Shutter L, Vespa P, Bruder N, Connolly ES Jr, Citerio G, Gress D, Hanggi D, Hoh BL, Lanzino G, Le Roux P, Rabinstein A, Schmutzhard E, Stocchetti N, Suarez JI, Treggiari M, Tseng MY, Vergouwen MD, Wolf S, Zipfel G, Neurocritical Care Society. Critical care management of patients following aneurysmal subarachnoid hemorrhage: recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference. Neurocrit Care. 2011 Sep;15(2):211-40. [199 references] PubMed

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2011 Sep

Guideline Developer(s)

Neurocritical Care Society - Medical Specialty Society

Source(s) of Funding

Neurocritical Care Society with the assistance of an unrestricted grant from Actelion Pharmaceuticals who had no involvement in any aspects of the conference including selection of topics, participants, or development and production of the proceedings

Guideline Committee

International Multi-disciplinary Consensus Conference on the Critical Care Management of Subarachnoid Hemorrhage

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Financial Disclosures/Conflicts of Interest

Relevant financial relationships are those in which an individual (including the individual's spouse/partner) in the last 12 months has had a personal financial (any amount) relationship with a commercial interest producing health care goods or services. A table listing all relevant financial relationships is available in the original guideline document.

Guideline Status

This is the current release of the guideline.

Guideline Availability

Electronic copies: Available from the Neurocritical Care Society Web site .

Availability of Companion Documents

The following is available:

- Critical care management of patients following aneurysmal subarachnoid hemorrhage: recommendations from the Neurocritical Care Society's multidisciplinary consensus conference. Slide presentation. 23 p. Electronic copies: Available from the Neurocritical Care Society Web site .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on July 3, 2012. The information was verified by the guideline developer on August 15, 2012. This summary was updated by ECRI Institute on October 28, 2013 following the U.S. Food and Drug Administration advisory on Acetaminophen. This summary was updated by ECRI Institute on March 10, 2014 following the U.S. Food and Drug Administration advisory on Low Molecular Weight Heparins. This summary was updated by ECRI Institute on September 18, 2015 following the U.S. Food and Drug Administration advisory on non-aspirin nonsteroidal anti-inflammatory drugs (NSAIDs).

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